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1. Introduction

In this time of dwindling resources, economic uncertainty, climate change, global conflict and both natural and manmade disasters causing massive impact to whole communities and cultures, there is a significant need developing for new leadership, for a new way. The increasing global competition in technology leads to a concept called Engineering Leadership including leadership skills and engineering competencies. They address the "Real Problems facing mankind" like energy security (D. Apelian, 2007, pp. 21-30). Greenhouse effect, the diminishing ozone layer, water and air pollution, the growing desserts, energy related problems along with global economy recession are the issues that seriously challenge the day-to-day people's life and are directly related to engineering paradigms. In today's ultra-competitive business world focused on customer satisfaction, engineers must not only be technically competent, they must also have requisite interpersonal traits relating to the leadership insights to excel in a complex economy. In other words, world-class engineering leaders are needed to increase productivity. The curriculum of their approach features an innovative direction based on using technical knowledge and leadership skills. The issues in the 21st century framework not only need deep understanding of non-technical perceptions, but also a successful experience of leading human resources is vital.

Engineering leadership consists of three principles named 3I: Innovation, Invention, and Implementation (Ed Crawly& Joe Schindall , 2008). Desirable fields of leading companies such as product development, system engineering and integration and also project management need interdisciplinary themes of knowledge. A successful engineering leader is equipped with individual competencies, uses resource and technology in an organizational frame and gets profitable results .He/she also should be aware of work culture and organization informal relationship. Three angles – Technical Leadership, Professional Leadership, and Personal Leadership – are necessary components for building and sustaining excellence. The problems of imbalance are evident and the way for constructing a sound leadership balance is inevitable.

Around the 1960 and on to today, the market trend is toward customer satisfaction. Achieving this new paradigm, engineering is to be more flexible and adaptable to the demands and expectations of stakeholders. The top – down traditional hierarchical structure doesn't act properly any longer. Managing change doesn't mean only controlling it, rather understanding it, adapting to it where necessary and guiding it when possible (Carter McNamara, 1997). The history of engineering leadership backs to Cyrus the Great, Persian king, who combined managerial characteristics with army dexterities to lead the significant kingdom of Persia. Cyrus was an intellectual leader, who was equipped with both charismatic authority and humanity respects. According to historical documents, he ordered to establish several welfare facilities for the people of his territory in order to protect them against out-border enemies and dangers. He built a huge iron-made dam in a valley between two mountains in the north eastern Asia (Azad, Abul kalam, 1960). Cyrus is cited in holy books like holy Tanakh, Bible and Quran as well, due to historical evidences and proofs. He is the only Gentile to be designated as Messiah, a divinely appointed leader, in the Tanakh (Isaiah 45:1-6). Some contemporary muslim scholars have suggested that the Qur'anic figure of Dhul-Qarnayn is Cyrus the Great. This theory was proposed by Sunni scholar Abul Kalam Azad and endorsed by Shi'a scholars Allameh Tabatabaei, in his Tafsir al-Mizan and Makarem Shirazi. He is introduced in Quran as a leader with the following characteristics: persuasion, wealthy, governing in a vast territory from far west to far east, builder of a huge dam as a fortress, just, participative leader, strong management and wise decision-making (Holy Quran, verses of Kahf). Three main issues were mentioned by Cyrus : 1- Goal setting ; 2- Strategic decision making and determining suitable path to achieve ;and 3- Distributing the results suitably (Hedrick,Larry ,2006 , P.17). According to Professor Richard Nelson Frye: "… the figure of Cyrus has survived throughout history as more than a great man who founded an empire. He became the epitome of the great qualities expected of a ruler in antiquity, and he assumed heroic features as a conqueror who was tolerant and magnanimous as well as brave and daring. His personality as seen by the Greeks influenced them and Alexander the Great, and, as the tradition was transmitted by the Romans, may be considered to influence our thinking even now." On another account, Prof. Patrick Hunt states:"If you are looking at the greatest personages in history who have affected the world, 'Cyrus the Great' is one of the few who deserves that epithet, the one who deserves to be called 'the Great'. The empire over which Cyrus ruled was the largest the ancient world had ever seen and may be to this day the largest empire ever."

Nowadays the emphasis on various principles is observed, where the key components of effective engineering leadership is the ability to motivate and equip people by being able to communicate clearly , manage and organize conflicts ,and develop creativity and technical tasks. Engineering leaders will be called upon to foresee developing threats to our environment and sustainability, and they will need to bring their messages effectively to political leaders. They will have to understand and cross multidisciplinary boundaries, because solving the most difficult problems will involve multiple, interacting and conflicting causes and effects. Language skills, cultural competency, and other soft skills will be brought into a comprehensive systems analysis of their work (Barlow , 2008). Piani believes that engineers can provide better public policy advice to government (Piani, 2010). Engineering leadership methods are useful for mid-level managers due to their responsibility between top managers (strategy decision making needs leadership aspects) and operational managers (technical proportion is more emphasized). In the current information technology century, running an organization needs science and art, the former calling engineering where the latter is linked to leadership. Much of the frustration and dissatisfaction in industry is directly related to the lack of these components attachment.

Engineering leader recognizes that in addition to the technical expertise, true technological leadership requires several key abilities such as critical thinking, emotional intelligence, organizing people from multiple disciplines and cultures and the spirit for innovation and entrepreneurship. Influence is not necessarily a function of time, status or project experience but rather of perseverance, passion, ability to overcome challenges and capacity to understand and recognize personal strengths and the viewpoint of others. The emphasis in engineering leadership goes to three fields: System engineering concept, Economic consideration and organizational skills.

2.
Definitions

Engineering leadership is defined as the technical leadership of the innovative conception, design and implementation of new products, processes, projects or systems supported by invention of enabling technologies to meet the needs of customer satisfaction as well as the society. Engineering leadership is a term to state process of envisioning, designing, developing and supporting new products and services to a set of requirements, within budget and to a schedule with acceptable levels of risk to support the strategic objectives of an organization (Dr. Wade H. Shaw ,2003,P.5). According to the Managerial Grid Model, an engineer leader sits on the top diagonal coordinates and is recognized as the closest estimate to an ideal leader who cares to both people and product in a reasonably balanced manner (Blake and Mouton, 1964).

Being a leader in a chosen field of science or engineering is precariously balanced against the need for organizational leadership – all wrapped up with managerial skills. The leader must have a passion for science and engineering, and balance the need for exploration and explanation with the pressures of broader organizational leadership. At the same time the leader must inspire and lead often large and diverse teams to prosecute the required solutions, all the while meeting enhanced governance aspirations and customer/client engagement/management. The question of transactional and transformational leadership and the aspiration of charismatic leadership remain extant; while engineers and scientist are often confronted by a complex problem space and a more complex solution space. In traditional leadership paradigms, it is situational leadership based on solid values with value reinforcement that defines an effective leadership. Importantly the leaders must understand that there is a transition we are moving through, which has been a paradigm shift from characteristic based leadership models of better, faster, smarter, to a value based model of professional, courageous, self starting, etc. Scientific leadership must be multi-polar, multi paradigm and the choices made on a basis of context and situation the leaders find themselves in (Quinn and Sadagopan, 2010).

3.
Engineering Leadership Requirements

Engineering leaders exist to develop and sustain products and services using systems engineering principles in project organizations which is widely used in nowadays' complex business environment. Since HR role is rarely ignored, lead and nurture people involved in the projects need managerial skills beside the technical knowledge related to the problems faced. Any projects running by an engineering leader should be fully clear in answer to three crucial questions:

1. What is the current situation?

2. Why does the situation need to be improved?

3. How does this passing step to the paced? (Dr. Wade H. Shaw 2003,P.7)

Engineering Leaders are people who can create significant change in both followers and organization to which they are associated (Iain Hay , Flinders University). They should lead change in culture, strategy , structure and informal relations. They must be equipped with deep knowledge and concentrate on three main fields: Business concepts, Human resources and Learning & Development. Setting strategic business objectives, determining organization capabilities, assessing employee leadership and technical competencies are categorized in business concept class. Human resource includes training, career path development, optimized performance and recruiting high quality workforce. In learning and development continuous learning, increasing knowledge, finding progress opportunities and industry – university link will be mentioned. Finally, engineering leadership is divided mainly into business leadership focusing on customer satisfaction through updated leading approach and technical leadership mentioning details and specific information on unique subject.

Engineering leadership is categorized in the field of transformational leadership. Transformational leaders elevate people from low level of needs focused on survival mentioned in Maslow's hierarchy, to higher levels.

(Kelly, M.L., 2006) (Yukl, G.A. 1989). Engineering leader requires transformational ability to create innovation and effectiveness especially in the initiation phase of any technical change process where visionary and committed leadership is critical for success (Davenport, 1993). Transformational leaders influence followers by setting challenging expectations, creating mutual respect, displaying exemplary behaviors, and focusing on followers' needs and higher-level motives (Avolio, Bass& Jung, 1999).

Such kind of leaders are said to engender trust, administration, loyalty and respect amongst their followers (Barbuto, J.E. 2005,pp.26-40.). Since engineering leadership is known as a new paradigm in management, transformational leadership principles can be hired for that field.

The four common I's is mentioned in the following:

1. Idealized influence: Charismatic vision and being wholly accepted by followers.

2. Inspirational motivation: Capacity to motivate others achieving the forecasted goals.

3. Intellectual stimulation: Encouraging innovation and creativity among group members.

4. Individualized consideration; Coaching to the specific needs of followers.

(Hall, J., Johnson, S., Wysocki, A. & Kepner, K. , 2002) (Simic, I. 1998., pp. 49-55.)

(Southwest Educational Development Laboratory, 2004) (Leithwood, K. & Jantzi, D. (2000), p. 112.)

The core competency of engineering leaders can be grouped as: technical capabilities, business/management capabilities and communication capabilities. These capabilities can be developed at progressive stages of a career, through a combination of formal training, on the job learning, and formal or informal mentoring approaches. While foundation engineering courses focus on technical and, to some extent, business aspects, managerial capabilities are further developed through on the job learning and postgraduate or industry based training. The communication capabilities required for effective leadership may best be cultivated through strong formal or informal mentoring relationships.

5. Capabilities of Engineering Leaders

The engineering leaders' potential to put up with issues running in the organization is divided into four group which is followed by some details each;

1. The attitudes of leadership: Core personal values and character.
   - Initiative: ability and willingness to take risks.
   - Decision making in the face of uncertainty.
   - Responsibility, urgency and will to deliver: commitment to the absolute responsibility to find best alternatives due to presence of obstacles or constraints.
   - Resourcefulness and flexibility: embrace various views and make best use of different related sources.
   - Ethical actions and integrity
   - Equity and diversity
   - Visions and intention in life for progress
   - Self awareness and self-improvement: defining career path
2. Relating: Developing key relationships and networks.
   - Inquiring and dialoguing : create constructive dialog
   - Negotiation, compromise and conflict resolving: find mutually acceptable solutions.
   - Advocacy
   - Diverse connections and grouping
   - Interpersonal skills: mention both individual and organization needs and objectives.
   - Structured communications: be able to create a structure and strategy to formal communications.
3. Making sense of context: Make a mental map of the complex environment.
   - Awareness of the societal and natural context
   - Awareness of the needs of the customer or beneficiaries
   - Enterprise awareness: understanding the goals and culture, shared beliefs and strategies.
   - New technology appreciation
   - System thinking: thinking holistically to force on critical features.
4. Visioning: Future awareness.
   - Thinking creatively
   - Defining various solutions

- Technical knowledge and critical reasoning

Many theorists, emphasizing on economic side of leadership, mention three skills including managing people, managing resources and showing technical competence (Economics for Future Leaders, 2009).

Shaw introduces the Result Achievement Capability of an engineer leader through an input-output model as below (Shaw, W.H.,2003):

Figure 1. Result Achievement Capability

Performance of an engineer leader is expected to be measured carefully and comprehensively. Job performance generally refers to behavior that is expected to contribute to organizational success (Campbell, 1990). However there is no consistent, overall definition of performance (yukl, 2006). Many distinct conceptualizations are often lumped together under the umbrella of leadership performance, including outcomes such as leader effectiveness, leader advancements, and leader emergence (Kaiser et al, 2008). Engineering leader performance could be referred to productivity, career success of the leader, performance of the subordinate group or organization, welfare and subordinate satisfaction or leader emergence. In recent years, emotional intelligence has been claimed by some as the best predictor of leader success (Goleman, 1995). However, others would suggest that success is determined by the sense of shared group membership that creates the psychological connection between the follower and leader (Macnaughtan, 2010).

6. Emergence of Engineering Leaders

The engineering industry and its major participants around the world are facing multiple parallel challenges that are sure to have a lasting impact. Challenges include the global financial crisis, ongoing mergers between professional services firms, a declining professional skill base in developed countries relative to demand, the shift to a multi-nodal world, and changing technologies in response to issues such as climate change. Demands on industry and business leadership have rarely been more significant, and it is in this context that true leadership involves creating beneficial change, not maintaining stability. Thus the questions become “where to lead?” and “how to lead?” The answers to those questions have little to do with traditional business models or engineering technology, and as such threaten to expose weaknesses in the existing cadre of industry leaders. Rather, answers will be found externally – by understanding the emerging global social context – and internally, through a better understanding of self. Such an inquiry reveals that the prevailing mindsets that frame government, industry and business no longer align with current reality. Hence the real test of engineering leadership is to effectively reframe the problems that engineers are being called upon to solve, and the methods and partnerships by which that is achieved (Fleming, 2010).

The search for the characteristics or traits of leaders has been ongoing for centuries. Students of leadership have produced theories involving traits, situational interaction, function, behavior, power, vision and values, charisma and intelligence among others. However in the very field of engineering leadership engineering part of the leader is of a great importance. One could logically claim that how an engineer leader was born inherently as an engineer! Trait theory could not be applied to the engineering part of the engineer leader. In any way an engineer needs to be trained and learn the skills. In reemergence of the trait theory, a leader has a set of individual traits: intelligence, adjustment, extraversion, conscientiousness, openness to experience, general self-efficacy. Adding to this set of distinguishing elements, an engineer leader must have a mathematical shape of mind and practical set of skills. This paradigm appears to be more applicable and reasonable. Furthermore researches are being presented recently on the emergence of an engineering leader using CAS (Complex Adaptive Systems) and analyzing it to identify the essence of emergence of such type of leaders (Salmani, 2010).

More practically Drew has another claim. He believes that engineers require the input of other team members over whom they have no formal authority or power. Being able to influence these individuals to meet the timelines, quality and cost constraints is a challenging yet essential skill. While a manager often operates from a position of authority, a leader does not always enjoy that luxury. A leader influences others to prioritize resources to achieve the leader's goals. Having a high level of self awareness and developing a keen interest in acquiring rounded leadership skills will help set young engineers down the path to being a successful leader (Drew, 2010). Being more delicate, Ahuja believes that engineering leadership is a by-product of spirituality (Ahuja, 2010).

7. Effective Engineer Leaders

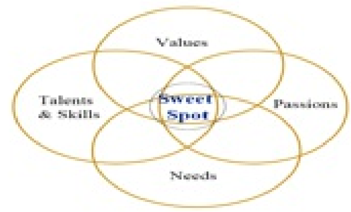
People believed leaders are charismatic and they are usually born but nowadays a new paradigm is spread which expresses that leaders are made and leadership skills are not rare traits anymore. In view of increasing global competition, engineering leadership today should be built on the reinforcement of product engineering education, that is, the education of those who innovate and put product into production (Bernard M.Gordon).

Investigating the case studies of successes , the impact of globalization , failures in running companies ,analyze the problems and potentials in intercultural and interdisciplinary collaboration, all prove that emergence of effective engineering leaders are crucial. To be an effective engineering leader, it is important to have developed a deep understanding of the underlying knowledge of engineering, science and technology (Massachusetts Institute of Technology).

An effective engineering leader categorizes the elements of competency into three main classes : 1- knowledge-base emphasizing on science and management fundamentals , 2- engineering ability, skillful to formulate , identify the problems , understand culture , environment and global responsibilities ,and 3- professional leadership attributes including effective communication , individual welfare consideration , intelligence inspiration and ability to function in multi disciplinary and multi cultural teamwork. Mentioning basics of engineering leaders, it is clear both organization profitability and individual welfare are important. Besides, ethics also plays an important role: “I was keen to rule a great land, an integrated empire where multi cultural people live in a peaceful manner without involving in tribal fight" (Hedrick,Larry, 2006 , P.36).

Leaders should complement their human related skills with engineering principles. Engineering leaders' qualities can be developed and will be continuously refined by more learning, experience and desire. There are four valuable parameters stressed by an effective engineer leader: needs, passions, values, and talents & skills. The shared proportion by the mentioned factors gives the "Sweet Spot", the effective engineer leaders' mission.

Figure 2. effective engineer leaders' mission



To mention a successful engineering leader, Lee Yakuka as a transformational leader saved Chrysler Automobile industry. First he understood the employees do not have the suitable challenge for progress in the company. He spread friendly leadership principles among workers. Effective workforce is known to be the most productive assets in different countries (Salmani , Davoud , 2005 , p.162). In other words Yakuka performed Erosmatic Leadership style .Emphasizing on workplace environment and close relation between official staffs and workers in production line, he believed four criteria as survival factors:

1.
Caring

2.
Sharing

3.
Respect

4.
Responsibility (Salmani , Davood ,1997, p.5)

Erosmatic leadership has common indicators with Servant Leadership model. According to Larry Spears definition, servant leadership has ten identifying characteristics: listening, empathy, healing, awareness, persuasion, conceptualization, foresight, stewardship, commitment to the growth of others, and building community. They are also applicable as the infrastructures of leadership based on love.

Nowadays Engineering leaders borrow their leadership authority in the rational-legal authority framework. Neither traditional nor charismatic authority can support or improve the technical abilities of a leader. However a former traditional leader or an existing charismatic leader can obtain engineering requirements and be considered as an engineering leader. Cyrus the Great had a charismatic authority while smart attitude was an added value to it and formed him as an engineer leader.

We have several questions to answer: What is the view of engineering leadership in the next century? What are the unique qualities required to lead the organizations of tomorrow? The core dilemmas future engineers face (by 27 most senior executives) are expressed as below:

- broad-based leadership vs. high-visibility leaders

- independence vs. interdependence
- long-term vs. short-term
- creativity vs. discipline
- trust vs. change
- bureaucracy busting vs. economies of scale
- people vs. productivity
- leadership vs. capability
- revenue growth vs. cost containment

Truly effective engineering leaders in the years ahead will have personas determined by strong values and beliefs in the capacity of individuals to grow (Beckhard , Richard, 1996). They will mention an image of the society in which they would like their organization, including core technical details and leadership dexterities.

They believe the future can and should be shaped by both engineers and leaders. Engineering leaders won't be rewarded for ordinary tasks and style of running organizations. They are people who can create significant changes in both followers and the organization which they are associated with. Due to the competitive variable environment, the primary responsibility for engineering leaders is based on change. In the following years, innovative organizations are to survive in uncertain competitive technological environments (Salmani , Davoud ,1997 , p.37). Four main classes of engineering leaders' responsibility are: First, it's necessary to make a compelling case for change. Second, it's important to inspire a shared vision through coaching and conscious role modeling strategies. Third, change needs to be led. Finally, change needs to be embedded by monitoring progress, changing appraisal and reward system and hiring staff with a commitment to collaboration. Future engineering leaders emphasize on lifelong foundation for perpetual improvement. Three most important competencies related to future engineering leaders are:

1. Leadership (leadership , strategic directing and entrepreneurship)

2. Management (planning, change and improvement, process, products and services, people / human resources)

3. Business (supplier relationship, information, finance and accounting)

A newer theory to describe engineering leaders expresses them as artists (Pinto , Jim, 2004). Going through the details of this new theory, it claims there will exist many engineering leaders but a few of them accomplish the strategic goals.

Engineering leaders are expected to satisfy some main issues such as belief in oneself, passion for the job, love of people and capacity for aloneness which means mostly leaders are blamed for misfortunes, so they should be psychologically competent for alteration surveillance (Charles Handy , The leader of the future).

8. Criticism of Engineering Leaders

The potential situation for engineering leader to abuse power is the most vital issue for criticism since technical knowledge and decision making are inclusive for a unique person (Stone, A.G., Russell, R.F., & Patterson, K. ,2006). Respecting moral values and limiting personal takings should be crucially mentioned in engineering leadership qualification. Many people call engineering leader as engineering charisma who confines various techniques and sources. In history, there existed some leaders abused their power and authority, resulted in destruction and manslaughter. Therefore the “dark side of charisma” should mostly be banned. Major engineering leaders’ misunderstandings will result in organization breakdown. Some are:

1- Weakness in determining environmental change, technology, competitive advantages and consumer needs.

2- Being unable in allocating suitable resources and equipment.

3- Having wrong market evaluation.

4- Ignoring human side of workforce or lowering the priority of human behavior in organization’s vision.

Some leaders may have narcissistic tendencies, thriving on power and manipulation. (Yukl, G.A. (1989) & Bass, B.M. (1997)). Our future engineering leaders must understand the societal impact of their profession, be well – versed in technology and function in global enterprise. They also motivate people and organizations to improve the quality of life around the world. The aim in reaching Quality of Work Life theory is expanding employees motivation by presenting challenging jobs which brings respect and job diversity more (Salmani , Davood , 2005 , p.15).

From another point of view, Trevelyan believes that developing leadership and management skills in young engineers can be more difficult than for other people because of predispositions and assumptions reinforced social values, expectations and engineering education (Trevelyan, 2010). These include:

- Solo technical expertise distinguishes an engineer,
- Engineering practice is all about technical problem solving (and design),
- The engineer who manages to solve the problem first is the hero,

• A ‘solid performer’ is someone who works quietly by himself on the technical details and gets the job done,
• Engineers start with problems that are clearly defined in writing and devise logical solutions,
• Team work means dividing the work between individuals and doing it individually, and
• Communication is a means of information transfer.

Researches on the realities of engineering practice reveal how powerfully these assumptions mediate the behavior of young engineers, denying them the ability to learn effective leadership skills (Trevelyan, 2010).

Looking to the future, it is clear that educating tomorrow's leaders will become an increasingly prominent part of engineering programs. In recent years, the profile and knowledge basis for the related fields of 'global engineering education' and 'entrepreneurship engineering education' have grown considerably, and partnerships across these communities will be an important factor in the future development of excellence in engineering leadership education (Graham , Ruth , 2009).

In closing, it can be said that there are some risks associated with engineering leadership. Engineering leadership must be accompanied by responsibility to ensure the commitment to the good of organization.

Engineering leaders ideally have participative or democratic leadership style although they might fall in the dark side of charisma or become a dictator by misunderstanding the mission of a leader.

9. Engineering Leadership and Democracy

Leadership is an essential component of democracy and its evolutionary political processes. While democracy has been called the "last form of government" and has spread considerably across the globe, no one can deny the strong binding between successful and wise leadership and accomplishment of democracy in an organization as workplace democracy, or vaster, in a society. There are multiple books and papers published on studying different forms of leadership that potentially pave the way to achieving democracy and maintain it as well (Brooker, P., Johanson, O., and others). As rapid changes occur in technology and our environment and life, one would thought of the best form of leadership that is firstly general in terms of governing and influencing skills and secondly is able to speed up obtaining of freedom and equality which we call them together democracy. Engineering leadership could be considered as one way of leadership, considerably powerful, which we believe that it has a causal relationship to democracy. A good example of this fact is what Cyrus the great did in the ancient time, relative to his time, location and situation. The premise of our causal model which is explained in the following is that engineering leadership styles are likely to influence democracy in an organization (workplace democracy) or society. In our research the indicators of democracy are: 1-freedom, which in turn includes political right, economic right, and civil liberty, and 2-equality (discussed in egalitarianism literature in details) .

We divide the subject of engineering leadership into two main parts: technology and humanity; in the first part, basically technology gives rise to better communications. In other words Information Technology (IT) is developed in the context of technology. Subsequently IT results in increment of information for the people, which in turn results in improving awareness. Awareness has the key role in providing knowledge and rising up the sense of the issues going on in the environment. This valuable spiritual and mental property – knowledge- gives ability to the people. This kind of ability brings power and influence in the people side. A society with the power distributed and owned by the people, embraces freedom and equality; these principles are reflected in all citizens being equal before the law and having equal access to power and the freedom of its citizens is secured by legitimized rights and liberties which are generally protected by a constitution. Obviously this type of society does not accept any form of government but democracy (Salmani, 2005). In contrast, the malfunctioning of this chain is literally as followed: bad communication results in wrong information; that results in unawareness; unawareness brings no knowledge; without knowledge, there is no ability and the people become disable in influencing their own life. Disability in the society brings force and tyranny by minority and democracy disappears. So engineer leaders can accelerate the way to accomplishment of democracy by his/her technological skills which are mainly emerged in the form of communication. Therefore our first hypothesis is that there is a positive relationship between IT-enabled change and democracy. Due to Galdima & Gan, the indicators of IT-enabled change are initiation, adoption and implementation.

From the humanity point of view, engineering leader can take the advantage of erosmatic leadership as mentioned earlier. This part is playing the role of "art" in engineering leadership expertise. Erosmatic leadership is measured by four interrelated and interdependent variables namely: caring, sharing, respect, and responsibility (Salmani, 1997), while responsibility in turn has two forms: individual responsibility and social responsibility. So the second hypothesis is that there is a positive relationship between erosmatic leadership and democracy.

According to erosmatic leadership context, one of the main pillars of this paradigm is trust; trust between leader and subordinates. While trust is an important key component of erosmatic leadership, openness is introduced as one of the five requirements of trust construction (Salmani, 1997). When we let the people enter into our circle of trust and we share our opinions with them, we have given them the courage to trust us. Members should openly share matters. Openness gives the leader the opportunity to observe the feedbacks of his actions and to correct it for the sake of maintaining the system. Obviously clear communication is the primary requirement and tool to achieve the openness. So communication influences the erosmatic leadership. Moreover a good leader, carrying love as a torch in his leading mission, has direct and positive influence on IT-enabled change by taking the role of either IS transformational leader or IS transactional leader (Galadima & Gan, 2007). Therefore our third hypothesis is that a balance between IT-enabled change and ersomatic leadership has influence on democracy.

10. Mathematical model

There are different distinct approaches that have appeared to date in which numeric techniques and computer simulation are used in leadership research. Agent-based models, system dynamics modeling, genetic algorithm approaches and several other methods have been applied to leadership concept (Hazy, J.K., 2007). Studying leadership in Complex Adaptive Systems (CAS) paradigm is also of a great interest in present days' literature (Solow, D., 2010).

Path analysis was developed by Sewall Wright as a method for studying the direct and indirect effects of variables hypothesized as causes of variables treated as effects (Wright, 1921, 1934). More than 40 years passed before path analysis was discovered as a tool for social sciences research (Klem, 2003). Blalock and Duncan, two sociologists, utilized this technique in their 1971 publication, Causal Models in the Social Sciences. The use of the technique increased during the 1970′s following the development of computer programs to perform covariance analysis (Ibid). A path diagram and a corresponding path model describe a set of equations summarizing complex scientific ideas in terms of statistical relationships. In this paper, a structural model of the relationships among the constructs is developed as shown in figure 3. Here "IT-enabled change" and "erosmatic leadership" are exogenous variables and "democracy" is endogenous variable.

Figure 3. the conceptual model of EL and democracy relation

Indicators structure

In figure 4, the measurement model of our three unobservable factors (IT-enabled change, erosmatic leadership, democracy) is illustrated:

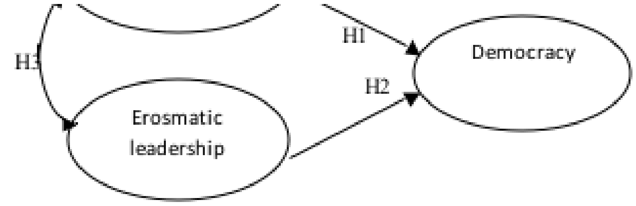
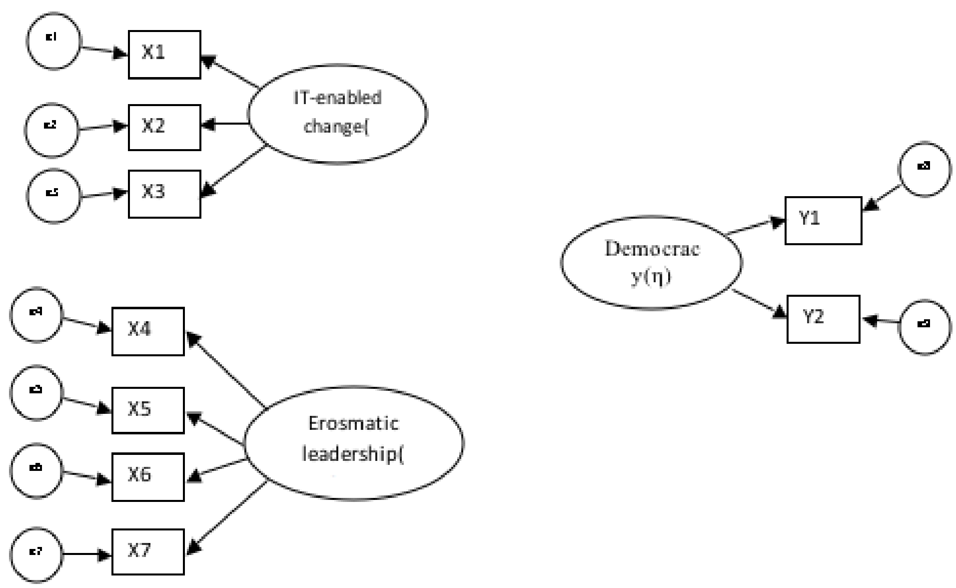


Figure 4. the measurement structural model

Let ξ_1 : IT-enabled change, ξ_2 : erosmatic leadership, η: democracy. As it was explained earlier, three hypotheses are available:
H1: there is a positive relationship between IT-enabled change and democracy
H2: there is a positive relationship between erosmatic leadership and democracy
H3: a balance between IT-enabled change and ersomatic leadership has influence on democracy

Figure 5. the structural path analysis



11. Discussion and Conclusion

The Engineering Leadership may totally be divided into two important categories: Business Leadership and Technical Leadership (Colello,Jerry , Engineering Leadership : Processes and Requirements , United Technologies Corporation , Ohio , USA). The growing interdependence between technology and economic and social foundations of modern society has resulted in an increasing number of opportunities for engineers to exercise their potentials as leaders, not only in business and government sectors but also in the nongovernmental organizations. To prepare the engineers exploit opportunities, they must understand the principles of leadership and be able to practice them in growing proportions as their careers advance.

Engineer Leaders as transformational leaders

Let X1: *initiation*, X2: *adoption*, X3: *implementation*. Exogenous variables X1, X2, and X3 are indicators of IT-enabled change. Hence the measurement equations for the model are derived as:

X1= $\lambda_{X1}\xi_1 + e1$ **(1)**
X2= $\lambda_{X2}\xi_1 + e2$ (2)
X3= $\lambda_{X3}\xi_1 + e3$ (3)

In matrix form the equation can be summarized as:

$$X_{\xi_1} = \xi_1 \lambda_{X_{\xi_1}} + E1 \quad (4)$$

where: E1= [e1 … e3] : error variances of IT-enabled change indicators

$\lambda_{X_{\xi_1}} = [\lambda_{X1} \dots \lambda_{X3}]$: factor loadings of IT-enabled change

$X_{\xi_1} = [X1 \dots X3]$

Now let X4: *caring*, X5: *sharing*, X6: *respect*, X7: *responsibility*. Exogenous variables X4, X5, X6, and X7 are indicators of erosmatic leadership. Hence the measurement equations for the model are derived as:

X4= $\lambda_{X4}\xi_2 + e4$ (5)
X5= $\lambda_{X5}\xi_2 + e5$ (6)
X6= $\lambda_{X6}\xi_2 + e6$ (7)
X7= $\lambda_{X7}\xi_2 + e7$ (8)

In matrix form the equation can be summarized as:

$$X_{\xi_2} = \xi_2 \lambda_{X_{\xi_2}} + E2 \quad (9)$$

where: E2= [e4 … e7] : error variances of erosmatic leadership indicators

$\lambda_{X_{\xi_2}} = [\lambda_{X4} \dots \lambda_{X7}]$

articulate the vision in a clear and appealing manner, explain how to attain the vision, act confidently and optimistically, express confidence in the followers, emphasize value and ethics with symbolic actions and empower followers to achieve the designed goals (Stone, A.G., Russell, R.F., & Patterson, K. , 2006).

: factor loadings of charismatic leadership

$X_{\xi_2} = [X4 \ldots X7]$

The measurement variables for democracy are: Y1: *freedom*, Y2: *equality*. The measurement equations for this factor are derived as follows:

$$Y1 = \lambda_{Y1}\eta + e8 \qquad (10)$$

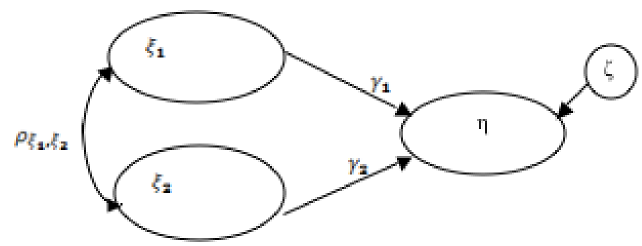
$$Y2 = \lambda_{Y2}\eta + e9 \qquad (11)$$

In matrix form, we have:

$$Y_\eta = \eta\lambda_{Y} + E3 \qquad (12)$$

Where λ_Y represents the factor loadings for democracy measurement variables ($\lambda_1 Y = [\ \lambda_1 Y1 \ \ \lambda_1 Y2]$) , and E3 stands for error variances of democracy measurement variables (E3= [e8 e9]).

To survive in a complex business market, including global challenges of IT-related tasks, he needs not know only techniques but also human issues. Engineering leaders are necessary to exist in order to address people issues, business issues and goals, strategies, and motivation in the organization. Engineering leaders' qualification consists of technical profession and precise insight to lead people, so that the followers obey the superior deliberately. These days it is inadequate that leaders are charisma but they must also know the process of parts assembly, system thinking, updated production systems and technical details of a profession. The key role of engineering leadership is creating economic value and national competitiveness. The emphasis in engineering leadership goes to three fields: system engineering concepts, economic consideration and organizational skills.



The above structural model is defined by the structural equation:

$$\eta = \xi_1\gamma_1 + \xi_2\gamma_2 + \zeta \qquad (13)$$

where γ_1 and γ_2 are path coefficients (standardized regression coefficients) and ζ error variance for the exogenous factor η. ρ_{ξ_1,ξ_2} is the Pearson Correlation Coefficient of ξ_1 and ξ_2 .
By collecting empirical data, one can feed the model and evaluates the model fit goodness using typical methods like Discrepancy function, GFI, CFI, RMS, …
The analysis is an exploratory model. Due to the situation and regarding to our position in accessing to the indicators, the authors have not gone further in collecting data.

Cyrus the Great is introduced as the first Engineering leader. He was taking advantage of a combination of qualities: science, knowledge, and experience which were all obtained through time during his career. He also cleverly used his common sense and artistic management to fulfill the profound role of a leader in his era. As is engraved on his well known Cylinder, he, for the first time, declared the principles of democracy and human right. Today engineering leaders can use IT and IS in order to extend the democracy. This research at the end presents a mathematical model to investigate the effect of engineering leadership on the establishment and maintaining of democracy based on structural path analysis. The mathematical model proposes a causal relation which engineering leadership has on democracy. Assuming the existence of a causal relationship, we defined a linear dependency between the two factors, which could be formulized and calculated by linear regression method.

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